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# DEVELOPMENT OF PERFORMANCE MEASURES FOR ORGANIZATIONAL LEVEL AVIATION MAINTENANCE MANAGERS

Wayne H. Anderson

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# THESIS

## DEVELOPMENT OF PERFORMANCE MEASURES FOR ORGANIZATIONAL LEVEL AVIATION MAINTENANCE MANAGERS

by

Wayne H. Anderson

June 1977

Thesis Advisor: C. P. Gibfried

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Material Control Officer are evaluated to define their respective objectives and develop appropriate measures which reflect their efficiency and effectiveness in achieving those objectives. The use of these measures is intended to provide effective feedback data for planning and control functions as well as for objective performance appraisal.

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# DEVELOPMENT OF PERFORMANCE MEASURES FOR ORGANIZATIONAL LEVEL AVIATION MAINTENANCE MANAGERS

by

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Lieutenant, United States Navy
B.S., Iowa State University, 1967

Submitted in partial fulfillment of the
requirements for the degree of

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# ABSTRACT

The development of objectives reflecting the functions of an entity together with the determination of appropriate measures to evaluate the accomplishment of those objectives are fundamental prerequisites for strategic management planning and control.

Following the guidelines of a systemmatic analysis model presented in this thesis, the assigned functions of the organizational level Maintenance Officer and Maintenance/Material Control Officer are evaluated to define their respective objectives and develop appropriate measures which reflect their efficiency and effectiveness in achieving those objectives. The use of these measures is intended to provide effective feedback data for planning and controlling functions as well as for objective performance appraisal.

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# I. INTRODUCTION

By its nature, management deals primarily with information. The requirements for accurate, current and pertinent feedback data are obvious for the planning and controlling phases of any manager's functions. A significant area of feedback data includes the measurement of performance.

Performance measurements derive value from the impact of their use. They are used routinely in descriptive models to explain the relationships seen in a situation and subsequently to chart progress toward achievement of objectives or desired performance goals. Performance measurements are also used in predictive models to forecast performance at a future time or situation. In addition, performance measurements are used with optimizers to provide decision or exception models. This last model generally concerns making a choice between alternative actions by using some kind of optimizer or pre-defined specification.

Regardless of their use, performance measurements must adequately assess the dimensions of the measures they represent. In turn, the measures must be deliberate and be developed with careful attention to evaluate important objectives. And finally, the objectives must be chosen to reflect the true purpose for which a function or responsibility exists. These criteria form the basis for the development of effective performance measures.

# II. PROBLEM STATEMENT

Within the Naval aviation maintenance community, no paradigm presently exists to systemmatically evaluate maintenance performance at the organizational level. Although a comprehensive management information system exists, it is commonly accepted that its application is too general, and its usefulness at the organizational level is impeded by a seemingly overwhelming abundance of disjointed and inapplicable data.

It is recognized that managers frequently encounter situations where decisions involving human dimensions impact upon performance. However, it is not the intent of this paper to develop measures evaluating human behavior and attitudes, but rather to develop measures of task performance as they relate to achieving specific objectives with the most efficient utilization of resources.

The goal of this paper is to analyze the functions and responsibilities of key organizational level maintenance managers, as presented in the Naval Aviation Maintenance Program (NAMP) Manual, define the primary objectives of these managers, and then determine what existent data would adequately serve to measure their performance.

To accomplish this task, the objectives of the Naval Aviation Maintenance Program will be briefly summarized to provide insight for those readers not intimately familiar with aviation maintenance. Also, the three level concept of maintenance and the structure of the organizational level will be discussed briefly to provide a background for the

interrelationships which exist among the three levels of maintenance as well as for those interrelationships which exist among maintenance managers within the organizational level. A comprehensive review of the Maintenance Data Collection Subsystem as it applies to organizational level maintenance managers will then be presented in order to screen those data reports currently available for consideration in extracting data parameters for the analysis. Next an analysis model outlining the steps to be followed in the development of performance measures will be introduced. Finally, using the model and data parameters available from existing reports, some performance measures will be developed for the organizational level Maintenance Officer and Maintenance/Material Control Officer.

Due to time constraints, development of performance measures for the Assistant Maintenance Officer, Division Officers, and Branch Officers will not be addressed. It is intended, however, that sufficient guidance will be provided through the development of measures for the Maintenance Officer and Maintenance/Material Control Officer to permit effectual development of performance measures for these other maintenance managers at the command level.

# III. BACKGROUND

In May of 1959, the Chief of Naval Operations established the Naval Aviation Maintenance Program (NAMP) to provide an integrated system for performing aeronautical equipment maintenance and related support functions. Subsequent to its implementation in the fall of 1959, the Naval Aviation Maintenance Program has been periodically revised to incorporate improved methods and techniques, including the three levels of maintenance concept. To provide for maintenance data collection, man-hour accounting, and aircraft accounting systems, the Naval Aviation Maintenance and Material Management System (3-M) was incorporated as a part of the NAMP in 1965.

Recognizing a need for revision, updating, and promulgation of the major implementing directives of the NAMP as a cohesive series of publications, the Chief of Naval Operations directed consolidation of these directives into a single family of documents in 1968. The result of this endeavor was promulgated as OPNAV Instruction 4790.2, frequently referred to as the NAMP Manual. It presently consists of four volumes which outline the maintenance policies, procedures, and responsibilities for the conduct of the Naval Aviation Maintenance Program at every level of maintenance throughout naval aviation.

## A. NAVAL AVIATION MAINTENANCE PROGRAM

The Naval Aviation Maintenance Program is a

comprehensive management control system whose primary objective is to achieve and maintain maximum material readiness, safety, and conservation of material. To accomplish repair of aeronautical equipment and material which will ensure optimum economic use of resources, the NAMP provides for three levels of maintenance: organizational maintenance, intermediate maintenance, and depot maintenance. Policies for the administrative and management interrelationships among these three levels are provided by the NAMP as well as policies establishing the assignment of maintenance tasks and defining the maintenance responsibilities for each level. Furthermore, the NAMP provides an extensive management information system which encompasses the collection, analysis and use of data to improve material readiness and safety.

## B. THREE LEVEL CONCEPT OF MAINTENANCE

The foundation of the Naval Aviation Maintenance Program is the three level maintenance concept. This concept is designed to provide optimum utilization of manpower, facilities, material and funds through the establishment of standard organizations, procedures, and responsibilities. The three levels of maintenance are organizational maintenance, intermediate maintenance, and depot maintenance.

### 1. Organizational Maintenance

The functions accomplished at the organizational level of maintenance generally consist of day-to-day maintenance tasks normally performed by an operating unit in support of its own operations. These tasks include

equipment inspections, equipment servicing, equipment handling, "on-equipment" repair, removal and replacement of defective parts and components, incorporation of designated technical directives, and the administrative duties of record keeping and reporting.[Ref. 1, p. 1-1] Naval operating units assigned organizational level maintenance activies include squadrons, detachments, and Operation Maintenance Divisions.

### 2. Intermediate Maintenance

Intermediate level maintenance activities provide support for operating units through designated maintenance functions. These functions include calibration of designated components, "off-equipment" repair, test, inspection and modification, manufacture of certain non-available parts, incorporation of designated technical directives, and providing technical assistance to supported units.[Ref. 1, p. 1-2] Intermediate level activities are known as Aircraft Intermediate Maintenance Departments (AIMDs) and are organized as departments both ashore at Naval Air Stations and Naval Air Facilities as well as afloat on aircraft carriers and other ships which carry naval aircraft.

### 3. Depot Maintenance

Maintenance functions accomplished at the depot level generally apply to material requiring major overhaul or complete rebuilding of parts, assemblies, and end items. The depot level of maintenance supports lower categories of maintenance by providing engineering assistance and performing maintenance which is beyond the capability of the lower level activities.[Ref. 1, p. 1-2] In addition, depot

level maintenance functions include calibration of equipment, incorporation of designated technical directives, manufacture of parts, and the overhaul, repair and modification of aircraft, engines and related equipment. Depot level maintenance activities are known as Naval Air Rework Facilities (NARFs).

## C. STANDARD STRUCTURE OF ORGANIZATIONAL LEVEL OF MAINTENANCE

The Naval Aviation Maintenance Program provides standard organizations with explicit responsibilities at each level of maintenance. The standard structure for the organizational level of maintenance is illustrated in the organization chart presented in Figure 1. The key personnel within this organization are the Maintenance Officer, and the Maintenance/Material Control Officer. Their functions will be discussed later during the development of their respective performance measures.

At the top of the organization is the Maintenance Officer who is responsible for the overall management of the maintenance effort. The Assistant Maintenance Officer assists the Maintenance Officer in this regard and also supervises the activities of the staff divisions.

The staff divisions include the Analysis Division, the Quality Assurance Division, and the Administration Division. The Analysis Division provides the qualitative and quantitative analysis information utilized to monitor maintenance practices within the department. The Quality Assurance Division provides support to ensure proper quality of maintenance is performed by the department. Clerical and administrative services are provided by the Administration

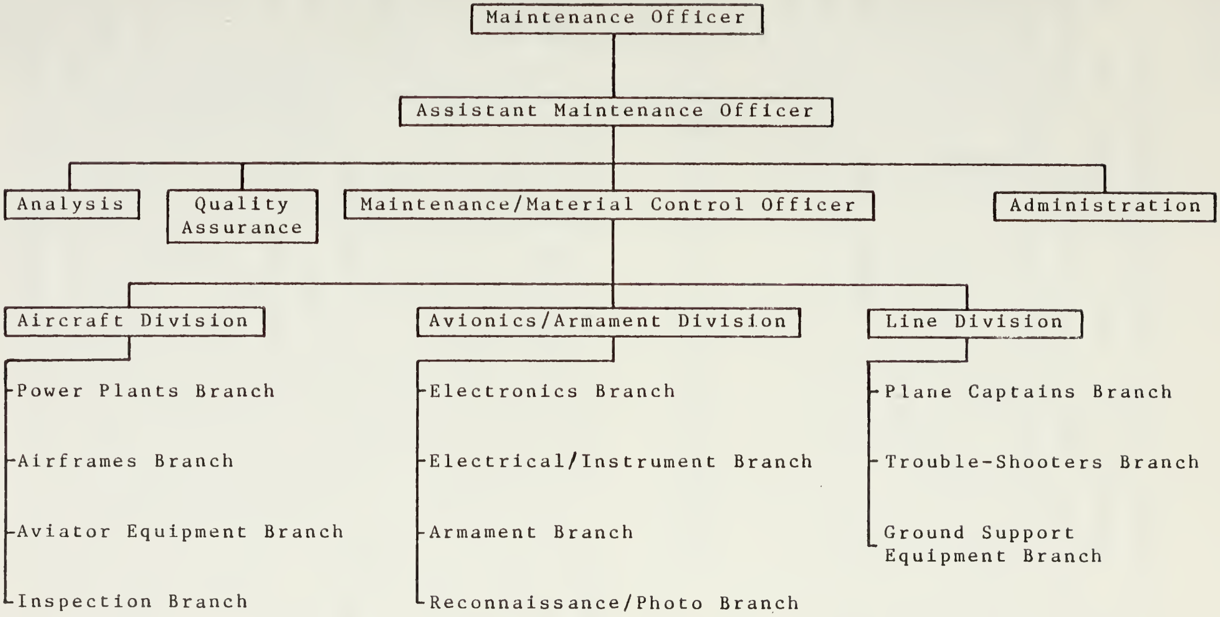

Figure 1 - ORGANIZATIONAL LEVEL ORGANIZATION CHART

Division.

The Maintenance/Material Control Officer is responsible for the productive effort and material support of the department. Production divisions are involved in the accomplishment of maintenance actions and are separated into functional areas which include the Aircraft Division, Avionics/Armament Division, and the Line Division. Each production division is further broken down into specialty areas which are called Branches. Branches are further divided into Work Centers for more refined identification when more than one shift is utilized or when detachments are deployed.

## D. MAINTENANCE DATA COLLECTION SUBSYSTEM

The Maintenance Data Collection Subsystem (MDCS) was developed as an integral part of the Navy Maintenance and Material Management System (3-M) and provides the data input to the Naval Aviation Maintenance Program. The Maintenance Data Collection Subsystem is a management information system designed to provide statistical data relative to maintenance personnel utilization, equipment maintainability and reliability, equipment configuration, equipment readiness and utilization, maintenance material usage, material non-availability, maintenance and material processing times, and weapon system and maintenance material costing. The MDCS includes Man-Hour Accounting (MHA) data, Maintenance Data Reporting (MDR), Material Reporting (MR), Aircraft Statistical Data (ASD), Training Device Statistical Data (TDSD), and Ground Support Equipment (GSE) statistical data. The first four of these categories are the most germane for organizational maintenance managers and will be discussed in detail.

### 1. Man-Hour Accounting

The Man-Hour Accounting system was introduced to account for the working time of the assigned labor force. It accomplishes this objective using the exception principle. Whenever a person reports to a maintenance activity, he is assigned a work center code and a labor code. The work center code identifies the functional work area to which the person is assigned while the labor code identifies the primary type of labor assigned. Whenever a person is employed for any purpose other than that for which he was assigned, he submits a Man-Hour Accounting card to report the deviation from his primary assigned routine. Man-hour Accounting cards are collected daily and machine processed. The output of this system provides the following reports:[Ref. 2, p. 3-2 to 3-4]

Master Roster Listing (MHA-00): A monthly detailed listing of personnel assigned by work center, labor code and grade code.

Daily Work Center Labor Code Listing (MHA-1): A detailed listing, by work center, of all MHA cards submitted during the preceding day.

Monthly Work Center Labor Utilization Report (MHA-2): A summary, by work center, of all labor transactions for the month.

Monthly Grade Code Utilization Report (MHA-3): A summary, by grade code, of all man-hours available to each labor code.

Daily MHA Validation Report (MHA-E1): A listing of MHA cards which failed to pass machine validation.

Currently, Man-Hour Accounting is optional at the direction of the cognizant Type Commander. Consequently, many organizational activities will not have access to many of the reports listed. However, all activities are required to maintain a Master Roster Listing (MHA-00).

### 2. Maintenance Data Reporting

The Maintenance Data Reporting system was designed to provide data related to direct labor expenditure, equipment, component and part reliability, and technical configuration. It accomplishes this objective through the use of coded information recorded on source documents which describe the maintenance actions performed. Two source documents are utilized: the Visual Information Display System/Maintenance Action Form (VIDS/MAF) and the Support Action Form (SAF). The VIDS/MAF is used primarily to document "on-equipment" maintenance actions as well as the removal and subsequent processing of repairable components. The SAF is used to record data related to man-hours expended in performing repetitive non-repair tasks such as servicing, cleaning, inspections, etc... After a maintenance action has been performed and the coded information has been recorded on the proper source documents, the documents are collected for machine processing. The following reports intended for organizational level maintenance managers are provided by the Maintenance Data Reporting System:[Ref. 2, p. 3-5 to 3-25]

Daily Production Report (MDR-1): A detailed listing, by work center, of all SAFs and VIDS/MAFs submitted during the previous day.

Monthly Production Report (MDR-2): A summation, by work center, of all maintenance actions, support actions, and technical directive compliances submitted during the month.

Job Control Number Consolidation Report

(MDR-3): A consolidated list of all maintenance actions submitted during the month by the parent organization as well as those submitted by the supporting activity.

Technical Directive Compliance Report (MDR-4): A detailed list of the organization's technical directive compliance during the previous month.

System and Component Maintenance Report (MDR-5): A detailed monthly listing of items repaired on equipment; items removed, installed or replaced; and items processed through maintenance shops.

When Malfunction Was Discovered Report (MDR-6): A monthly tabulation of when discovered codes.

Maintenance Actions by Individual Item Report (MDR-7): A report listing maintenance actions submitted during the month on equipment that can be identified by bureau or serial numbers.

Failed Parts Report (MDR-9): A listing of all failed parts identified from VIDS/MAFs submitted during the month.

Repair Cycle Data Report (MDR-10): A monthly report listing the number of days of turnaround time and the elements that compose the turnaround time for each repairable component processed through the AIMD as documented on the VIDS/MAF.

No Defect Report (MDR-S-2): A monthly report listing the amount of time and effort expended on maintenance in which there was no malfunction.

Foreign Object Damage Report (MDR-S-3): A monthly report listing components replaced, repaired or condemmed as a result of foreign object damage.

Corrosion Control/Treatment Report (MDR-S-4):

A monthly report identifying corrosion control and corrosion treatment actions by bureau number and specific portion of the aircraft.

Maintenance Action by Bureau Number Report (MDR-S-5): A monthly report consolidating all maintenance actions in bureau number/serial number sequence.

Organization Work Center Report (MDR-S-6): A monthly report listing all organizational maintenance actions in work center sequence.

Organizational Maintenance Action by Component Report (MDR-S-7): A monthly report consolidating all maintenance actions by component.

Component Repair/Repair Cycle Report (MDR-S-8): A monthly report summarizing, by work center, all maintenance actions recorded during the month and the complete repair cycle data on each assembly/subassembly processed through the AIMD during the month.

Maintenance Action/Beyond Capability of Maintenance Report (MDR-S-9): A monthly report listing the action taken codes for maintenance actions taken by the AIMD.

Failed Part/Parts Required Report (MDR-S-10): A monthly report listing all failed parts and parts required by the AIMD.

### 3. Material Reporting

The Material Reporting system uses the VIDS/MAF and the material requisitioning document (DD 1348) as source documents to provide data relating material issues and turn-ins to activities as well as data to determine weapon systems costs and material expenditures in support of maintenance. The following reports are provided:[Ref. 2, p.

3-26, 3-27]

Issues and Turn-ins of Repairable Components Report (MR-1): A monthly report listing issues and turn-ins for each job control number during the previous month.

Exception Report (MR-2): A monthly report listing delays in turn-ins of defective components from the organizational maintenance activity to the AIMD as well as from the AIMD back to supply.

Pool Component Report (MR-3): A monthly report listing all issues from the rotable pool during the previous three months.

Component Turn-in Report (MR-4): A monthly report listing all components released from the AIMD during the past three months.

Component Control Report (MR-5): A monthly report listing the status of all repairable components and rotable pool quantities for the previous three months.

### 4. Aircraft Statistical Data

The Aircraft Statistical Data system is designed to provide data relating to operational readiness, flight data and aircraft inventory. Source documents for this system are Equipment Statistical Data (ESD) cards and Flight Data (FD) forms. The ESD cards provide an account of aircraft inventory gains and losses, changes in aircraft Readiness Reporting Status, Not Operational Ready (NOR) time by reason, Reduced Material Condition (RMC) time by reason, and Awaiting Maintenance (AWM) time by reason. The FD forms provide information regarding flight hours and the number of flights, landing and catapult take-offs. Reports from the Aircraft Statistical Data system include the following:[Ref. 2, p. 3-28 to 3-35]

Aircraft Master List (ASD-00): A monthly report listing aircraft inventory transactions and readiness status.

Daily Flight Report (ASD-1): A daily report listing all aircraft flight data submitted during the previous day.

Daily Aircraft Readiness Report (ASD-2): A daily report listing all aircraft Not Operational Ready (NOR) and Reduced Material Condition (RMC) data submitted during the previous day.

Monthly Aircraft Readiness and Flight Report (ASD-3): A monthly report summarizing all flight, NOR, RMC, and inventory data submitted during the previous month.

Monthly Aircraft Awaiting Maintenance Reason Summary (ASD-4): A monthly report summarizing Awaiting Maintenance (AWM) time by reason codes submitted during the previous month.

Monthly Flight Report (ASD-5): A monthly report summarizing flight data submitted during the previous month.

Daily ASD Validation and Balance Report (ASD-E1): A daily report listing ESD cards and FD forms which failed to pass machine validation.

# IV. MODEL FOR ANALYSIS

The development of performance measures requires a systemmatic and logical approach of analysis. This approach must include a working definition of terms together with specified procedures and the criteria to which these procedures must conform. The following framework for analysis of the parameters used in developing performance measures is a general approach and may apply to any functioning entity with specified objectives.

## A. DEFINING PERFORMANCE MEASUREMENT

Defining measurement is in itself, very illusive. As it applies to physics, measurement has been defined as:

> ...the assignment of particular mathematical characteristics to conceptual entities in such a way as to permit (1) an unambiguous mathematical description of every situation involving the entity and (2) the arrangement of all occurances of it in a quasi-serial order.[Ref. 3, p. 5]

However, as the term measurement applies to things in general, it may be defined simply as the business of pinning numbers on items used for evaluation purposes.

Since measurement presupposes something to be measured, no measurement can have any significance unless it is known what that something is. For the process of measuring performance then, it is imperative to know exactly what is meant by "performance".

Performance may be defined as the operating or functioning of an entity, usually with regard to efficiency and effectiveness. In this context, efficiency refers to the optimum relationship between inputs and outputs, while

effectiveness relates to the accomplishment of a purpose.

Performance measurement, consequently, is the assignment of numbers describing how well an entity accomplishes its purpose with regard to inputs, outputs, and objectives. The initial step in developing performance measures for any entity, whether it be an activity, program, organization or manager begins with the development of measurable objectives. Then, measurement of outputs and inputs logically follow in order to determine effectiveness and efficiency.

## B. DEVELOPING MEASURABLE OBJECTIVES

The first step in the evaluation of any entity is the formation of the overall objectives. It is impossible to devise appropriate evaluation methods for an entity unless there is an unambiguous statement of the anticipated results of that entity. Consequently, the first phase of performance measurement is the development of objectives for the functions being evaluated.

To be useful, objectives themselves must meet several criteria. First of all, they should reflect the purpose for which a function exists.[Ref. 4, p. 425] Too frequently, the real objectives of an entity are camouflaged among perceived stated ones. Furthermore, objectives should be structured to permit evaluation of the total performance of an entity and should address themselves only to priority matters, not routine ones.[Ref. 4, p. 426] They should also represent controllable elements for which the entity is both responsible and accountable and has the authority to influence.[Ref. 5, p. 12]

Additionally, objectives should include a statement of those specific conditions or indicators which must be met to satisfactorily accomplish the objective and should avoid relative terms and include a clear statement of what is

going to be accomplished, who is going to accomplish it, and when it is going to be accomplished.[Ref. 6, p. 13,16] Finally, objectives should reflect the results an entity plans to achieve rather than the activities in which it will engage.[Ref. 6, p. 16]

The formulation of objectives which are "real objectives" and not just "stated objectives" is a very demanding task. Frequently, objectives are stated to create an artificial aura appealing to pressure interests, while in fact, the functions performed support other objectives. This phenomenon might be observed in institutions of higher learning where the professed objectives are quality education. In reality, the operation of sports programs, the construction of exorbitant architectural structures, and immaculate grounds keeping functions would appear to support other objectives. The test of an objective of an entity is the determination of whether the entity will knowingly sacrifice other goals in order to achieve the objective.[Ref. 4, p. 425]

## C. MEASURING OUTPUTS AND INPUTS

One of the criteria presented for the development of objectives included the prerequisite that objectives reflect results rather than activities. It follows that in order to determine the degree to which objectives have been achieved, it is necessary to measure the outputs. In order to compare results achieved with the resources used in production, it is also necessary to measure inputs.

### 1. Output Measures

Similiar to the development of objectives, output measures also must meet several criteria.[Ref. 4, p. 426,427] One, output measures should relate as closely as possible to specific objectives and should approximate the

values expressed by the objectives. In order to formulate output measures which meet this criterion, each objective must be thoroughly analyzed. Two, like objectives, output measures should relate to ends and not to specific means which may be necessary to achieve objectives. Three, output measures should define and isolate specific things which will be examined in describing and evaluating the achievement of objectives. Four, they should reflect quality as well as quantity. Hence, products of different quality levels should be treated, as far as possible, as separate outputs.

### 2. Input Measures

Input measures reflect the resources consumed in the production of an output. They should reflect only those resources which are relevant and which are sensitive to changes in output levels. As with output measures, quality as well as quantity should be reflected in input measures.[Ref. 4, p. 427]

## D. PREREQUISITES OF MEASUREMENTS

Measurements are the end results of measuring something. To be beneficial, measurements in general require adherance to many prerequisites. Although few measurements in the working environment meet all of these prerequisites, most are useful if they meet only some of them.

### 1. Precision

Whether measuring inputs or outputs, measurements should be derived from a clear-cut and generally accepted process that involves well defined elements.[Ref. 7, p. 49] Furthermore, the sensitivity of measurements should be directly related to the accuracy required.

### 2. Timeliness

Measurements should be available in a timely manner to those who use them in order to take corrective action; otherwise they have little value.[Ref. 7, p. 49] This not only implies that the response time of obtaining a measurement be timely, but also that measurements reflect information that is current and up-to-date.

### 3. Integrativeness

Measurements should fit into the framework of measures established by the entity and should exhibit characteristics that are appropriate to its position within the framework.[Ref. 7, p. 49] For example, measurements used to gauge the performance of higher level managers should be broad and related to strategic planning decisions; conversely measurements used at lower managerial levels should be more pointed. Both the broad measurements and the narrow measurements should interlock.

### 4. Compensative

The value of the information a measurement provides must exceed the cost of generating the measurement.[Ref. 7, p. 49] Obvious as this may appear, this prerequisite is probably the most abused because of the subjectivity involved in quantifing benefits. Information derives value through the impact of its use and unless its use has a direct economic payoff, comparing benefits to costs is difficult, at best.

## E. MEASUREMENT STANDARDS

Measurement standards are designed to provide a basis for adjusting experience in widely different contexts.[Ref. 3, p. 88] Not all human experience takes

place at the same time or in the same circumstance, thus the ability to adjust a situation into an experience that would have taken place under some standard set of conditions provides the means to compare and communicate with other situations.

In the process of choosing standards, there are a few considerations that must be taken into account. First of all, a standard should be selected which minimizes the amount of adjustment required when times, people, and places change. Secondly, standards should specify the minimum expectations for results.[Ref. 8, p. 95] And thirdly, standards must be objective.

Performance standards permit management by exception methodologies through the use of objective and realistic standards. They are used widely to detect and alert managers of deviations from expected performance levels and help solve developing problems at the action point. Because performance standards specify minimum performance levels, their use promotes lateral communication between competitive departments.[Ref. 9, p. 24] In this context, deficiencies as well as superior performances are easily identified. This tends to encourage competitive organizations to exchange information in order to correct deficiencies and remain competitive.

# V. DEVELOPMENT OF MEASURES

One of the primary objectives of the United States Navy is to maintain a readiness posture of sufficient strength to carry out assigned missions. In Naval aviation, this primary objective is further defined and interpreted until it is ultimately translated into terms of operational readiness at the squadron level.

It is important to realize that operational readiness is not an output of only the maintenance resources of a squadron. Rather, the squadron's objectives to maximize operational readiness must include several inputs. These inputs include material resources, facilities resources, maintenance resources, operational expertise, and even the abilities of assigned crew members.

The organizational level maintenance department serves as a service organization and contributes to the operational readiness of the squadron primarily through the maintenance effort together with the employment of facility resources. The maintenance department's contribution to the operational readiness level through material resources is limited and is confined to liaison and monitoring functions with occasional prudent cannibalization activities when proper situations arise. Because the Maintenance Officer and the Maintenance/Material Control Officer are the most directly concerned with the management of the maintenance effort at the squadron level, their objectives must be in harmony with each other as well as with the operational readiness objectives of the squadron.

## A. MAINTENANCE OFFICER

As stated in the model, the first step in the development of performance measures is to determine the objectives for which functions exist. For the organizational level Maintenance Officer, the NAMP Manual explicitly states the primary assigned functions. These functions include:

(a) Administer the operation of the maintenance department in accordance with the NAMP Manual.

(b) Employ sound management practices in the handling of personnel, facilities, and material and in-work flow methods.

(c) Define and assign responsibilities, functions, and operations in accordance with existing directives.

(d) Organize the department and initiate requests for, and make recommendations relative to, changes concerning personnel, facilities, and equipment required to accomplish assigned tasks.

(e) Ensure the accomplishment of training for assigned personnel.

(f) Continuously and progressively analyze the mission of the department and ensure that timely planning is conducted and a statement of requirements to meet future needs is initiated.

(g) Ensure full and effective employment of assigned personnel.

(h) Ensure that the production output of the department is of proper quantity and quality in accordance with applicable specifications and directives.

(i) Maintaining liaison with other department heads and representatives of higher authority and other maintenance organizations.

(j) Promulgate and ensure internal compliance with maintenance, safety and security procedures to ensure that optimum performance is achieved.

(k) Schedule and hold periodic planning/informational meetings with all assigned officers/senior petty officers/senior noncommissioned officers.

(l) Ensure the monitoring of programs to prevent fuel, hydraulic, and oil contamination; foreign object damage; and corrosion, as applicable.

(m) Provide data analysis summaries to the commanding officer and other superiors in the chain of command as requested.

(n) Maintain pool aircraft when assigned by the controlling custodian.

(o) Ensure that the Individual Material Readiness List (IMRL) is frequently reviewed and necessary changes submitted, accurate equipage records are maintained, and required reports are submitted.

(p) Ensure effective support is provided the technical manual and directive verification program.

(q) Ensure the NORS/NFE status listing is validated, certified, and returned to supply on a daily basis.

(r) Ensure the efficient operation of the maintenance data reporting system.[Ref. 1, p. 3-3, 3-4]

In the analysis of these functions, it soon becomes apparent the Maintenance Officer's primary objective in managing the maintenance effort is to achieve maximum contribution to the squadron's operational readiness. This objective may be further broken down into four separate, but supporting objectives:

(1) Obtain optimum utilization of assigned personnel.

(2) Obtain optimum utilization of assigned facilities.

(3) Obtain optimum material support.

(4) Ensure proper maintenance procedures are conducted in accordance with applicable directives.

Ostensibly, these four objectives represent elements for which the Maintenance Officer is accountable for and has the authority to influence. Taken as a set, these objectives permit an evaluation of the overall performance of the Maintenance Officer. The only weak area in which these objectives do not comply with the model is the

relative terms with which they are stated. However, these relative terms may be replaced later with standards when appropriate measures are determined and some experience has been gained with their use. To determine appropriate measures, each objective must be evaluated separately and analyzed with respect to inputs and outputs.

### 1. Objective 1: Obtain Optimum Utilization of Assigned Personnel

The primary measure of the inputs for this objective necessarily must reflect the amount of labor available in the maintenance department. The total amount of labor available can be sub-divided further into areas of use, i.e. maintenance man-hours, training man-hours, and non-productive man-hours. Outputs for maintenance man-hours expended may be reflected to some degree in the number of items processed, number of flights, and flight hours flown. Other outputs are not quite so easily defined. Consequently, it sometimes becomes necessary to use input measures as surrogates for outputs.

Measures which indicate utilization of personnel include the following:

(a) Maintenance Man-Hours (MDR-2) - This measure indicates how busy the maintenance work force is in absolute terms.

(b) Maintenance Man-Hours (MDR-2) divided by Available Man-Hours (MHA-00) - This measure provides an indication of the extent of the labor force involved in productive activities.

(c) Maintenance Man-Hours (MDR-2) divided by Items Processed (MDR-2) - This measure provides some indication of the level of efficiency of the work force. The usefulness of this measure is degraded by the fact that each item processed does not necessarily require the same amount of labor.

Additionally, the process of determining which items are processed is virtually a random process. However, this measure could be a very valuable asset if processing time standards were developed and identified by work unit code and action taken codes for similiar type/model/series aircraft. Then by application of a variance concept, the Maintenance Officer could easily ascertain the efficiency of his departmental work force.

(d) Maintenance Man-Hours (MDR-2) divided by Flight Hours (ASD-3) - This measure provides some indication of the allocation of labor resources when the flight hours are identified by aircraft bureau number. When compared to fleet-wide standards, this measure indicates the effectiveness of the maintenance department's work force. The last statement assumes that flight hours are a product of maintenance labor inputs and are a measure of operational readiness.

### 2. Objective 2: Obtain Optimum Utilization of Assigned Facilities

Facilities in this context refer to hangar and hangar deck spaces, ground support equipment, test equipment and special tools. Each separate item is essentially an input to this objective while the outputs they provide are somewhat ambigious and difficult to define. To ensure the department has all the inputs it is allowed, the Maintenance Officer must determine the Individual Material Readiness List is accurate. He must also ensure that enough qualified personnel are trained to properly operate ground support equipment, special tools, and the various test equipment to preclude idleness. While none of the machine data reports in the MDCS system can provide this information, there are some measures which can be used to indicate utilization of

facilities.

(a) Awaiting Maintenance Time For Ground Support Equipment (ASD-4) - This measure provides an indication of unavailable or inadequate ground support equipment.

(b) Awaiting Maintenance Time For Hangar/Hangar Deck Spaces (ASD-4) - This measure provides an indication of unavailable or inadequate maintenance areas or utility services.

### 3. Objective 3: Obtain Optimum Material Support

To achieve its mission, a Maintenance Department must have an adequate source of repair materials. The supporting Supply Department together with the supporting Aircraft Intermediate Maintenance Department (AIMD) provides this source. The inputs the organizational level Maintenance Officer must provide to ensure his department recieves optimum material support is to continuously monitor and maintain liaison with the Supply Department and the local AIMD. The outputs then can be reflected in the following measures:

(a) Not Operational Ready Time, Supply (ASD-3) - This measure provides an indication of the amount of time an aircraft is not operationally ready and attributable to the process of obtaining replacement parts. While a Maintenance Officer has little control over this measure, he can favorably influence it with proper monitoring and liaison activities. In comparison with other similiar squadrons or fleet averages of type/model/series aircraft, this measure can indicate how well a Maintenance Officer is achieving his objective of obtaining the best

material support for his department.

(b) Reduced Material Condition Time, Not Fully Equipped (ASD-3) - This measure is similiar to the NORS measure, but reflects the amount of time an aircraft is in a state of reduced material condition for lack of replacement parts. By comparing with other similiar activities, the Maintenance Officer can use this measure to determine how well he is achieving his objective.

### 4. Objective 4: Ensure Proper Maintenance Procedures are Conducted In Accordance With Applicable Directives

The Maintenance Officer must exercise his authority to ascertain all maintenance procedures are conducted in accordance with applicable Maintenance Instruction Manuals (MIMs), the NAMP Manual, and other special program directives. This requirement is necessary to ensure the optimum material condition of squadron assets as well as the safety of maintenance personnel and aircraft crew members.

The primary inputs to this objective are training and labor expended in the accomplishment of tasks supporting special programs as well as routine maintenance actions. Outputs may be reflected in failure rates, number of maintenance actions performed with regard to specific components, number of components removed with no defects discovered, as well as many other supplemental measures. To adequately assess the accomplishment of this objective without incurring excessive analysis of data, the following primary measures are presented with the acknowlegement that other supplemental measures are available from MDCS reports.

(a) Foreign Object Damage Incidents (MDR-S-3) - This measure indicates the number of incidents caused by foreign object damage. By comparison with measurements derived from previous

experience, this measure may identify the lack of adherence to foreign object damage directives.

(b) Corrosion Control Man-Hours Expended (MDR-S-4) - This measure provides an indication of the effort expended in corrosion control treatment.

(c) Corrosion Control Items Processed (MDR-S-4) - This measure indicates the amount of corrosion control treatment achieved. When used in conjunction with man-hours expended on specific aircraft, the measures may provide an indication of the level of compliance with the existing corrosion control treatment directives.

(d) Failure of Components (MDR-S-7) - This measure indicates the number of failures during the previous month of components identified by Work Unit Code. An abnormally high volume of failures may indicate noncompliance with proper maintenance procedures.

(e) No Defect Components (MDR-S-2) - This measure indicates the numbers of repairable components forwarded to the supporting AIMD in which no malfunctions were discovered. This measure may reflect improper maintenance procedures at the organizational level as well as the intermediate level.

(f) Maintenance Actions by System (MDR-5) - This measure provides the number of maintenance actions processed on systems and components identified by Work Unit Code. By comparison with measurements derived from previous experience or fleet-wide averages for type/model/series aircraft, this measure can reflect the achievement of compliance with proper maintenance procedures.

(g) Maintenance Actions (MDR-5) divided by

Flight Hours (ASD-3) - This measure provides an indication of the number of maintenance actions processed by system per flight hour flown.

## B. MAINTENANCE/MATERIAL CONTROL OFFICER

The organizational level Maintenance/Material Control Officer is responsible to the Maintenance Officer for the overall productive effort and material support of the maintenance department. As stated in the NAMP Manual, his primary assigned functions include:

(a) Coordinating/monitoring the department workload.

(b) Maintaining liaison with the supporting activities and the local supply department to ensure that the squadron requirements are known and satisfied.

(c) Establishing procedures to effectively control the daily workload and the assignment of work priorities.

(d) Issuing maintenance instructions, as required, to ensure adequate communication and control.

(e) Ensuring that the full capability of the department is utilized in the support of the department work load.

(f) Submitting work requests to the supporting intermediate maintenance department for those functions beyond the capability/responsibility of the activity.

(g) Maintaining technical directive control procedures for the department by initiating all directive compliance actions, ensuring that required material is ordered, scheduling timely incorporation of technical directives, and issuing Technical Information Maintenance Instructions (TIMIs) and local Maintenance Requirement Cards (MRCs) as required to retain necessary control and ensure compliance.

(h) Conduct a monthly maintenance meeting and publishing a monthly maintenance plan.

(i) Attending the monthly maintenance meeting conducted by the supporting AIMD.

(j) Establishing procedures for controlling/directing cannibalization.

(k) Ensuring that functional maintenance

checkflights are conducted as required.

(l) Maintaining aircraft log and associated equipment records, including weight and balance data and inventory logs.

(m) Reviewing monthly MHA, MDR, and ASD reports to ensure effective utilization of personnel, equipment and facilities.

(n) Establishing procedures to monitor the aircraft statistical data requirements system and such other reports as required.

(o) Planning material requirements to support the department work load.

(p) Furnishing technical advice and information to the supporting supply department as to the identity and quantities of supplies, spare parts, and pool components required to support the department work load.

(q) Keeping the Maintenance Officer advised of the overall work load/material situation as it affects the department.

(r) Establishing procedures to ensure proper operation of tool rooms and the control/custody of accountable items.

(s) Reviewing allowance lists and the IMRL for adequacy, initiating action for revision as required.

(t) Establishing procedures to ensure the periodic inventory of tool boxes.

(u) Ensuring that divisions assign qualified personnel for the completion of scheduled maintenance and inspections.

(v) Maintaining close liaison with quality assurance, particularly when major components are changed.

(w) Providing records of aircraft discrepancies and corrective actions for the preceeding ten flights of the aircraft to pilots/air crews.

(x) Validating the NORS/NFE status listing on a daily basis.[Ref. 1, p. 3-8 to 3-9]

In the evaluation of these functions, it is important to remember that objectives developed for the Maintenance/Material Control Officer necessarily must be concordant with those objectives developed for the Maintenance Officer, the squadron, and the Navy. An analysis of these functions, consequently, reveals the primary objectives of the Maintenance/Material Control Officer to be the following:

(1) Provide optimum communications flow.

(2) Obtain complete and accurate documentation.

These objectives satisfy all the criteria of developing objectives as presented previously in the model with the possible exception of relative terms and specific conditions to accomplish the objectives. However, once measures are defined and experience gained with them, standards can be determined and used to explicitly state what requirements must be achieved to accomplish the objectives.

### 1. Objective 1: Obtain Optimum Communications Flow

In order to provide a centralized point to coordinate the maintenance efforts of the Maintenance Department, the Maintenance/Material Control Officer must furnish vehicles to transmit pertinent information to the levels where they may be acted upon. These vehicles are the inputs to this objective and may include such diverse items as maintenance plans, maintenance instructions, meetings, standard procedures, work and job priorities, work requests, material requisitions, and reports.

Although not available in the MDCS reports, amounts or numbers of each of these inputs provide measures reflecting how busy the Maintenance/Material Control Officer is in accomplishing this objective. How quickly and accurately these inputs transmit the required information to the proper locations is represented by the output measures.

It must be realized that while the flow of communications can impact upon performance outputs, there are many other variables which can affect them as well. It is difficult, if not impossible, to isolate all these variables to determine the sole impact of the communications inputs on performance outputs. Consequently, caution must be observed when applying output measures in order to

account for other variables. In addition to the use of input measures as substitutes for output measures, the following output measures may reflect the impetus of the communication flow.

(a) When Discovered Codes (MDR-S-7) - This measure indicates when failures of components were discovered. An excessive number of failures discovered before flights by the air crew may indicate a problem in communications flow as well as non-adherance to proper maintenance procedures. Conversely, an exceedingly small number of failures discovered during inspections may indicate inadequate inspection procedures.

(b) Not Operationally Ready Time, Maintenance (ASD-3) - This measure represents the amount of time an aircraft is not operationally ready due to maintenance (NORM). It may be further broken down into time not operationally ready for scheduled maintenance (NORMS) and unscheduled maintenance (NORMU). An excessive amount of NORMS time may indicated improper planning and scheduling while an excessive amount of NORMU time may indicate a problem in scheduling and assignment of priorities as well as improper maintenance procedures.

(c) Reduced Material Condition Time, Maintenance (ASD-3) - This measure indicates the amount of time an aircraft is in reduced material condition due to maintenance (RMCM). The aircraft may be flyable, but cannot perform all of its assigned missions. Like the previous measure, RMCM time can be broken down into reduced material condition due to scheduled maintenance (RMCMS) as well as unscheduled maintenance (RMCMU). The information this measure provides is similiar to

the information provided by the preceding NORM measure.

(d) Awaiting Maintenance Time Due to Backlog (ASD-4) - This measure provides some indication of workload requirements which are in excess of work center capability. An excessive amount of time may indicate improper scheduling and assignment of priorities.

(e) Technical Directive Compliance (MDR-4) - This measure provides the number of Technical Directive Compliance (TDC) actions completed during the previous month. When compared with the total number of TDCs issued, this measure indicates the extent planning and scheduling endeavors were accomplished.

(f) Jobs Completed (MDR-2) - This measure provides the number of Job Control Numbers (JCNs) completed during the previous month. When compared to the number of JCNs issued, this measure provides an indication of the productive effort achieved through scheduling and assignment of priorities.

(g) Cannibalization Actions (MDR-S-7) - This measure provides the number of items processed for cannibalization actions and indicates the extent of compliance achieved with respect to published control procedures.

### 2. Objective 2: Obtain Complete and Accurate Documentation

The Maintenance/Material Control Officer is assigned the function of ensuring the submission of data requirements involving aircraft statistical data, aircraft logbooks and other data applicable to the maintenance effort. Inputs to this objective are the establishment of procedures while

outputs are reflected in logbook entries, timely and accurate submission of required reports, as well as accurate submission of MDCS source documents.

Numbers of discrepancies in logbook entries, although not available in MDCS reports, may be discovered in administrative inspections and provide a measure for accomplishment of this objective. Discrepancies in required reports discovered at any level inside, as well as outside the command also provide a measure for this objective. However, only discrepancies in MDCS source documents can be obtained from MDCS reports. Measures reflecting documentation available from MDCS reports include the following:

(a) Man-Hour Accounting Errors (MHA-E1) - This measure provides the number of errors in man-hour accounting source documents to indicate the level of accuracy acheived in man-hour accounting documentation.

(b) Maintenance Data Reporting Errors (MDR-1) - This measure provides the number and type of errors in maintenance data reporting source documents.

(c) Aircraft Statistical Data Errors (ASD-E1) - This measure provides the number and type of errors in the aircraft statistical data source documents.

## C. MEASUREMENTS AND STANDARDS

The values obtained from the measures just developed represent the measurements to be used to appraise the achievement of objectives. During the development of the measures, particular attention was paid to select measures

which are available monthly. With the exception of those measures reflecting documentation which are available daily, all the measures developed are available from monthly MDCS reports. Consequently, it is believed values obtained from these measures will adequately achieve the timeliness criterion of measurements as presented in the model.

Furthermore, since most of the measurements can be readily obtained from existing machine reports without excessive analysis or revision of computer programs, the cost-benefit relationship of the compensative prerequisite is satisfied.

Since the existing formats of MDCS reports generally break down the data elements to reflect specific entities such as work centers, work unit codes, aircraft bureau numbers, etc..., prudent selection of measurements will permit the scope of evaluation to be refined as desired, thus achieving the integrativeness criterion of the model. Moreover, it may provide for the evaluation of objectives of subordinate managers.

The most obvious problem encountered in the development of performance measures for organizational level maintenance managers is the definite lack of relative statistics with which measurements can be compared to assess the accomplishment of objectives. Before a manager can improve his performance, he must have some standard of performance with which he can compare and relate to logically adjust the tools utilized in the management process. These standards can be developed from measurements obtained from previous experience and/or from aggregate measurements obtained at fleet-wide levels for similiar type/model/series aircraft.

# VI. CONCLUSIONS

The development of real objectives is a fundamental prerequisite for organizational maintenance management planning and control. Specific objectives derived from a systemmatic and logical method of analysis of assigned functions provide a goal-oriented approach to accomplishing managerial tasks. As a result, managers as well as subordinates know what is expected and are motivated to maximize their performance to achieve those objectives in the most efficient manner possible. Consequently, better use of time and material may be realized as well as the additional benefits of higher morale in the working environment.

To evaluate the achievement of objectives, measures must be selected which are sensitive to output levels and which reflect input resources maintenance managers have the authority to influence. Quantifiable results obtained from these measures then provide a result-oriented approach for which accomplishment of objectives are assessed.

The development of performance measures for the organizational level Maintenance Officer and Maintenance/Material Control Officer from existing MDCS reports is a demanding task. The abundance of data available from these reports and the inability to isolate specific variables reflecting only their input resources tends to further complicate the situation. However, the potential benefits to be derived from even defining approximate measures developed from systemmatic and logical methods of analysis and the subsequent determination of realistic measurements are numerous.

First of all, quantifiable performance measurements permit comparisons with developed standards. This allows

maintenance managers to identify problem areas early and to take quick corrective actions which may result in potential savings of expenditures in labor and material resources.

Also, performance measurements can be used to describe situations and assist in explaining relationships observed. As a result, trends can be identified and progress toward desired goals can be planned. Furthermore, performance at a future time or situation can be creditably forecasted based upon actual experiences with quantifiable data.

Perhaps the most valuable benefit to be derived from the development of useable performance measures is the capability it provides to evaluate the extent maintenance managers efficiently and effectively perform their assigned functions. This not only permits the manager to exercise self-discipline and control to reach desired objectives, but also provides a means for superiors to objectively appraise their performance.

The development of performance measures for organizational maintenance managers offers many potential advantages. However, before successful implementation can be effected, all personnel involved must subscribe to the measures developed. With proper support at both the command level and the working level, greater productivity and more efficient management of resources can be realized while simultaneously creating better managers.

# VII. RECOMMENDATIONS

Due to time constraints, this study was conducted using only theoretical analyses. To determine the extent of validity achieved for the measures developed, empirical research should be conducted using statistical correlation techniques. Further research in this area may help to isolate some of the variables identified in the data elements of developed measures.

The measures developed in this study are by no means complete. Each command has its own set of established goals and priorities. The measures presented in this study are intended for general application, while the development of supplemental objectives and measures remains a command perogative and responsibility. Furthermore, the development of objectives and measures for other organizational level maintenance managers in this study was waived due to time constraints for analysis. This is not to suggest they are not important, for they are. Following the framework presented in the text of this study should provide sufficient guidance for the development of objectives and appropriate measures for any level manager.

Finally, the analysis of the MDCS reports have revealed an obvious lack of availability of fleet-wide measurements for specific type/model/series aircraft. Research in this area to provide averages and standard deviations of selected measures needs to be investigated in order to permit evaluation of performance based on fleet-wide standards. Considering the potential benefits to be realized, further study in this area conducted now may be very cost effective in the near future.

# APPENDIX A

## GLOSSARY OF ACRONYMS

| | |
|---|---|
| AIMD | Aircraft Intermediate Maintenance Department |
| ASD | Aircraft Statistical Data |
| AWM | Awaiting Maintenance |
| ESD | Equipment Statistical Data |
| FD | Flight Data |
| GSE | Ground Support Equipment |
| IMRL | Individual Material Readiness List |
| JCN | Job Control Number |
| MDCS | Maintenance Data Collection Subsystem |
| MDR | Maintenance Data Reporting |
| MHA | Man-Hour Accounting |
| MIM | Maintenance Instruction Manual |
| MR | Material Reporting |
| MRC | Maintenance Requirement Card |
| NAMP | Naval Aviation Maintenance Program |
| NARF | Naval Air rework Facility |
| NFE | Not Fully Equipped |
| NOR | Not Operationally Ready |
| NORM | Not Operationally Ready, Maintenance |
| NORMU | Not Operationally Ready, Unscheduled Maintenance |
| NORMS | Not Operationally Ready, Scheduled Maintenance |
| NORS | Not Operationally Ready, Supply |
| RMC | Reduced Material Condition |
| RMCM | Reduced Material Condition, Maintenance |
| RMCMS | Reduced Material Condition, Scheduled Maintenance |

| | |
|---|---|
| RMCMU | Reduced Material Condition, Unscheduled Maintenance |
| SAF | Support Action Form |
| TDC | Technical Directive Compliance |
| TDSD | Training Device Statistical Data |
| TIMI | Technical Information Maintenance Instruction |
| VIDS/MAF | Visual Information Display System/Maintenance Action Form |
| 3-M | Navy Maintenance and Material Management System |

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